The Markov matrix versus the Duration, Category and Transition (DCT) matrix: a case study of land change in the Florida Coastal Ecosystems

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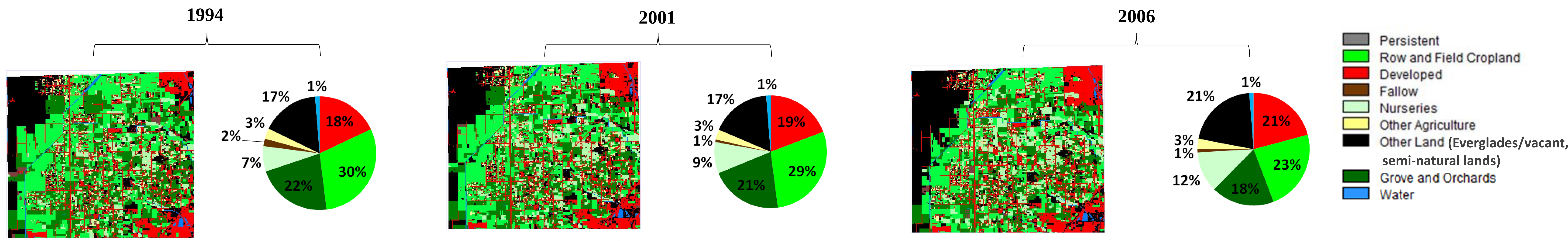
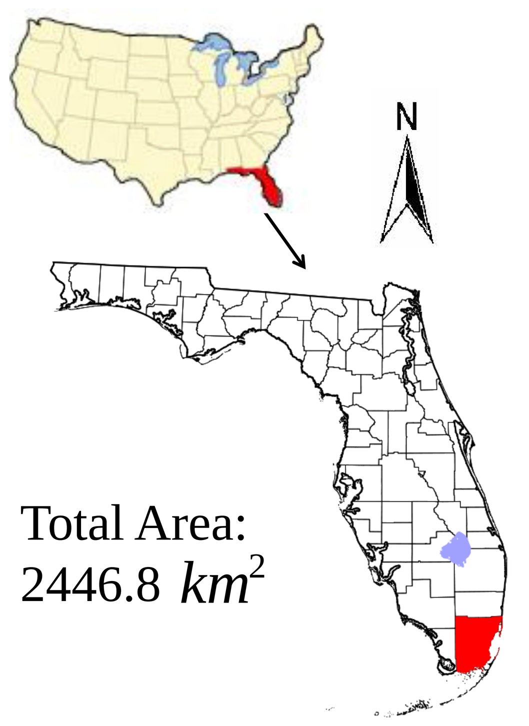
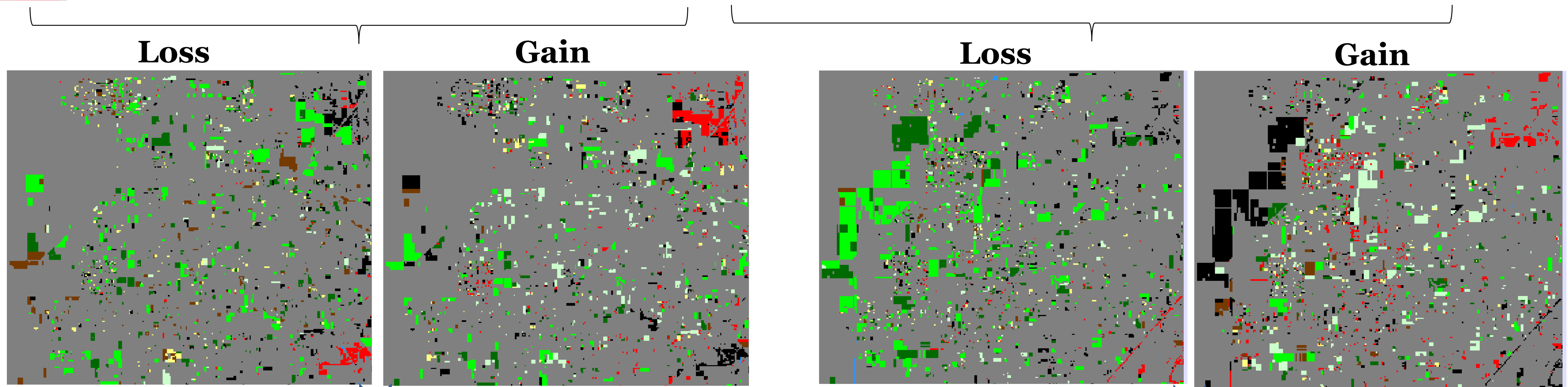
Introduction

A traditional way of analyzing and predicting land change over time is to use the Markov matrix, which results in a transition matrix that expresses a constant proportion of transition from one category to another during each time interval. In the Markov matrix, if the transition probabilities are stable over time, then the land change process is considered stationary over time. This is only one possible conceptual definition of stationary. If a study area shows a constant area of transition per unit time, then the study area would be considered non-stationary by the Markov matrix but would be considered stationary by the DCT matrix. In DCT matrix, the stationarity of transitions is measured by gross gains and gross losses of each category during the time intervals. DCT matrix also examines whether there are non-random transitions, given the allocation of categories in the maps. The empirical data are from the Florida Coastal Ecosystems study area in Redlands, Florida. The three years are: 1994, 2001, and 2006.





Total Area: 2446.8 km^2



Markov Probability Matrix (% of category)

1994 \ 2001	D	C	G&O	N	F	OA	OL	W	sum
D	0.96	0	0	0	0	0	0.03	0	1
C	0.02	0.86	0.03	0.04	0.01	0.01	0.04	0	1
G&O	0.01	0.05	0.89	0.03	0	0	0.02	0	1
N	0	0.04	0.01	0.92	0	0	0.03	0	1
F	0.03	0.41	0.10	0.07	0.21	0.03	0.15	0	1
OA	0.04	0.05	0.03	0.06	0	0.75	0.08	0	1
OL	0.05	0.03	0.01	0.01	0	0.01	0.88	0	1
W	0.01	0	0	0	0	0	0.01	0.98	1

2001 \ 2006	D	C	G&O	N	F	OA	OL	W	sum
D	0.97	0	0	0	0	0	0.02	0	1
C	0.01	0.76	0.03	0.07	0.02	0.01	0.10	0	1
G&O	0.02	0.05	0.80	0.05	0.01	0	0.08	0	1
N	0.02	0.01	0.04	0.91	0	0.01	0.01	0	1
F	0.15	0.09	0.03	0.15	0.33	0.04	0.23	0	1
OA	0.11	0.02	0.01	0.02	0.01	0.79	0.04	0	1
OL	0.05	0.02	0.01	0.02	0	0.01	0.89	0	1
W	0.03	0	0	0	0	0	0.03	0.94	1

Duration, Category and Transition Matrix(km^2/year)

1994 \ 2001	D	C	G&O	N	F	OA	OL	W	Gross Loss
D		0	0	0	0	0	2	0	2
C	2		3	4	1	1	4	0	15
G&O	1	4		2	0	0	1	0	8
N	0	1	0		0	0	1	0	2
F	0	3	1	1		0	1	0	6
OA	1	1	0	1	0		1	0	3
OL	3	2	1	1	0	1		0	7
W	0	0	0	0	0	0	0		0
Gross Gain	7	10	5	8	1	2	10	0	43

2001 \ 2006	D	C	G&O	N	F	OA	OL	W	Gross Loss
D		0	0	0	0	0	2	0	3
C	2		4	10	3	1	14	0	34
G&O	2	5		5	1	1	8	0	21
N	1	1	2		0	0	1	0	4
F	1	0	0	1		0	1	0	2
OA	2	0	0	0	0		1	0	3
OL	4	2	1	2	0	1		0	9
W	0	0	0	0	0	0	0		0
Gross Gain	11	7	8	17	4	3	26	0	76

D Developed · C Row and Field Cropland · G&O Grove and Orchards · N Nurseries · F Fallow · OA Other Agriculture · OL Other Land · W Water

Conclusion

- With DCT, both gains and losses per category can be examined because DCT treats gains and losses as two potentially different processes. Markov analyzes only the relative losses within the matrix's rows.
- It is easier to see large transitions with DCT than with Markov, since DCT shows total area of change per year as opposed to the percent of each category that has changed per interval.
- If the two time intervals are different durations, DCT is more interpretable than Markov since it calculates change on an annual basis. It is very difficult to standardize a Markov Matrix to a common duration since it calculates percent of change (by category) per interval.

Acknowledgement

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